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An Investigation of a Community Chickenpox Outbreak with a Fatal Case, Songkhla Province, Thailand, October 2022

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Abstract

In October 2022, a suspected chickenpox death was notified. A field investigation was done to verify the diagnosis and cause of death, describe the epidemiological characteristics, identify risk factors, and control the outbreak. We conducted a descriptive study and a matched case-control study. A case was defined as a person with multiple stages of skin lesions on at least two body areas in Subdistrict from 1 Aug 2022 to 24 Oct 2022. We reviewed medical records and searched for cases house-to-house. For the matched case-control study, cases were chickenpox cases residing in Bo Tru Subdistrict, from 1 Aug 2022 to 14 Oct 2022. Controls were neighbors without symptoms or chickenpox history, matched by age. Samples were tested using the reverse transcription polymerase chain reaction technique. Environmental surveys were performed. We identified 30 cases including the deceased, who was 49 years old. The median (interquartile range) age of the cases was 11 (7–38) years. Seventeen were elementary-school students. None of the cases received chickenpox vaccination or had a history of chickenpox. The secondary attack rate among household contacts was 41.2% (14/34). Reverse transcriptase polymerase chain reaction tests from three cases were all positive. Being a close contact with a case and sharing personal utensils were risk factors. We strengthened the surveillance system for early detection and treatment and provided risk communication in the community. Chickenpox cases should be isolated from susceptible persons. Standard treatment guidelines for complicated cases should be distributed among healthcare services.

Keywords: chickenpox, outbreak investigation, community, complications

Background

The varicella-zoster virus, commonly known as chickenpox, belongs to the herpesvirus group and is a highly contagious disease (R_0=6) with humans as its sole reservoir.[1] The virus usually spreads via droplets, aerosols, and by direct contact.[2] Characteristic symptoms include an itchy rash marked by fluid-filled blisters that eventually burst and form crusts or scabs. These lesions initially appear on the chest, back, and face, gradually spreading to other parts of the body, and last for four to seven days.[3] The incubation period is approximately 14 days (range 10 to 21 days) and individuals are contagious from one to two days before the onset of rashes until all lesions have crusted over.[2] In most cases, infection occurs only once and has lifelong immunity.[4] Susceptibility to infection is typically observed in individuals who have not been vaccinated or have not previously been infected. Close contact with cases and direct contact with chickenpox lesions are significant risk factors contributing to its spread.[2,5]

Chickenpox infection can lead to various complications, including skin and soft tissue infections, pneumonia, sepsis, encephalitis and death. The chickenpox fatality rate among children aged 1 to 14 years is one per ten-thousand and among adults is 21 per ten-thousand. Pneumonia is the most common cause of death. Populations considered at high risk for complications include infants, people over the age of 12, pregnant women, active smokers, and individuals with weakened immune systems.[6,7] It is recommended that individuals

who have never had chickenpox should receive two doses of the chickenpox vaccine. The vaccine has an effectiveness of 90% after two doses.[8]

On 2 Oct 2022, a joint investigation team from the Office of Disease Prevention and Control Region 12 Songkhla, was alerted by the Songkhla Provincial Health Office of a death from unknown cause of a person suspected to have either chickenpox or Mpox. This case was reported by Ranot Hospital in Ranot District, Songkhla Province. Subsequently, a joint investigation team comprising members from the Office of Disease Prevention and Control Region 12 Songkhla, Songkhla Provincial Health Office, and Ranot Hospital initiated a field investigation. The objectives were to verify the diagnosis and cause of death, confirm the outbreak, describe its epidemiological characteristics, identify risk factors, and provide recommendations and control measures.

Methods

Epidemiological Investigation and Descriptive Study

We reviewed the geographic and demographic data of Bo Tru Subdistrict and population. To assess the situation of varicella infection in Ranot District, Songkhla Province from 2021 to 2022, we compared the data of 2022 with a five-year median obtained from the Ranot Hospital database.

We investigated during 3–24 Oct 2022 in Bo Tru Subdistrict, Songkhla Province. We reviewed the medical records of the index case and conducted face-to-face interviews with Ranot Hospital healthcare staff and the family of the index case.

We defined a chickenpox suspected case as an individual residing in Bo Tru Subdistrict, who manifested at least two multi-stage skin lesions (vesicle, papule, macule, and crust), on at least two different locations of the body, between 1 Aug 2022 and 24 Oct 2022. A chickenpox confirmed case was any suspected case that tested positive for the chickenpox virus using reverse transcription polymerase chain reaction (RT-PCR).

An active case finding was performed by reviewing the database and medical records of both Ranot Hospital and Bo Tru Subdistrict Health Center. We compiled a line list of cases, diagnosed with chickenpox (international classification of diseases, 10th edition: B01), whose visit date ranged from 1 Aug 2022 to 24 Oct 2022. We conducted an active case finding in Bo Tru Subdistrict through face-to-face interviews with the individuals from the abovementioned list of cases (or their parents), using a semi-structured questionnaire. We conducted phone interviews with cases who were unable to participate in the investigation on the scheduled days.

To identify further cases that may not have been in our initial line list, local healthcare officers made announcements in Bo Tru Subdistrict for individuals with multi-stage skin lesions to contact the hospital, using a snowball approach. We interviewed the cases and identified their household members. We maintained the active case surveillance for an additional six weeks following the onset of the last identified case.

Laboratory Study

Because the index case manifested generalized multi-stage skin lesions, specimens including one lesion fluid sample were tested for Mpox virus by RT-PCR and sent to the Regional Medical Sciences Center 12 Songkhla. Two serum plasma samples from the index case were also tested for RT-PCR varicella-zoster and herpes simplex I and II viruses and sent to the National Iinstitute of Health. The specimens were all collected by Ranot Hospital's healthcare staff on 2 Oct 2022 before the case was referred to Songkhla Hospital.

On 14 Oct 2022, we collected two specimens from two suspected cases with active multi-stage lesions for RT-PCR testing for varicella-zoster in Bo Tru Subdistrict. The specimens were placed in a viral transport media and packaged at temperatures between 2–8°C and sent to a private laboratory (N-Health Laboratory) for PCR testing for the varicella-zoster virus.

Environmental Study

We conducted a walkthrough survey in Bo Tru Subdistrict to identify environmental factors that could enhance the transmission of the virus. We utilized a subdistrict map, observed daily activities and personal hygiene practices, and interviewed a community leader and three elementary school teachers.

Analytic Study

An age-matched case-control study was conducted to identify potential risk factors for chickenpox among individuals residing in Bo Tru Subdistrict between 1 Aug 2022 and 14 Oct 2022. The sample size was calculated based on an assumed odds ratio of 12.1 for attending activities with individuals who had chickenpox.[9] The required sample size was 23 cases and 23 controls, with a ratio of 1:1. Cases were suspected cases from the descriptive study. We defined a control as a neighbor of a case who lived within three kilometers from case's house and aged within one year of the case, exhibiting no symptoms, and having no history of chickenpox. We chose the controls from a pool of eligible controls living in Bo Tru Subdistrict. Data was

collected via face-to-face or phone interviews using a semi-structure questionnaire.

Statistical Analysis

Descriptive statistics included median with interquartile range (IQR), ratio, and proportion. To calculate the secondary attack rate within each household, we divided the number of second-generation cases (occurring 10–42 days after the primary cases within each household) by the total number of susceptible individuals living in that household (excluding primary cases and those with a history of chickenpox).

Exposure variables included demographic characteristics (gender, being a student at Bo Tru Elementary School) and risk behaviors (being a close contact with a case, sharing personal utensils, sharing room spaces, and attending religious activities). The main outcome was being either a suspected or a confirmed case. We calculated the odds ratio (OR) and 95% confidential interval (CI) for univariable analysis. For multivariable analysis, we used a multiple conditional logistic regression model by including variables with a *p*-value <0.1 from the univariable analysis. Results are shown in the form of adjusted odds ratio (AOR) and 95% CI. We analysed the data using Stata version 16.

Ethics

This study was a part of the routine activities of the Thai Department of Disease Control, Ministry of Public Health.

Results

Bo Tru Subdistrict of Ranot District, Songkhla Province comprises of 1,839 households and has a population of 7,455. There is one elementary school, a community mosque, and a health center. According to the Ranot Hospital database, there was an increase in the number of chickenpox cases in 2022, from two cases in July to 13 cases in late September, which surpassed the five-year median.

Source Case Identification

The index case was a 49-year-old Thai Muslim male living in Bo Tru Subdistrict. He worked in the fishery industry and had no reported underlying health conditions. He also had no history of prior chickenpox infection or vaccination. He was an active smoker, smoking approximately five cigarettes per day for over a decade. He lived with his wife and daughter, who both had history of chickenpox. On 12 September, he visited his 7- and 10-year-old cousins, who were both infected with chickenpox. He developed symptoms 11 days later. Initially he sought medical care at a local private clinic. However, his condition deteriorated quickly. He was initially suspected of having either varicella-zoster or Mpox infection. A chest x-ray revealed signs of severe pneumonia in both lungs. His condition continued to worsen and he passed away on 2 October (Figure 1).

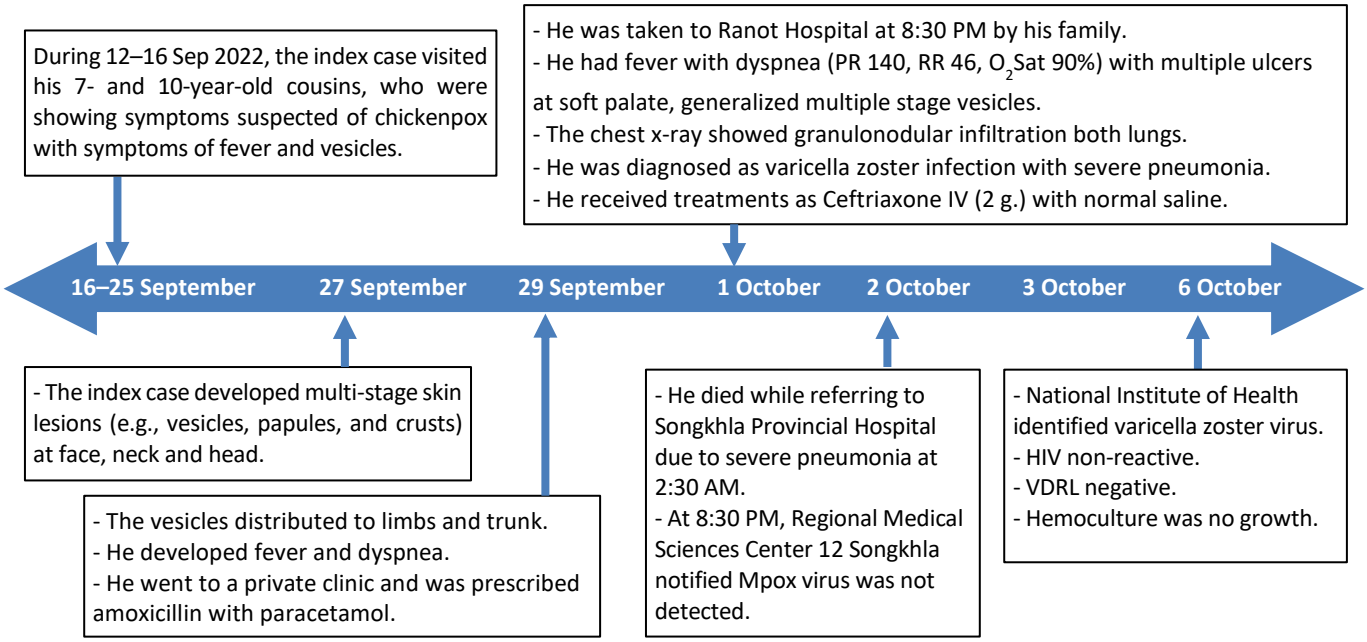

Figure 1. Timeline of chickenpox symptoms progression in the index case from first contact to death in Bo Tru Subdistrict, Ranot District, Songkhla Province, 16 Sep 2022–6 Oct 2022

Following this incident, we performed an active case finding and compiled a line list of 13 cases from the database and medical records of Ranot Hospital and Bo Tru Subdistrict Health Center. The identified cases

were their schoolmates and family members, which consisted of adults, teenagers, and children. The two boys attended Bo Tru Elementary School. A timeline of the epidemic curve in the school is shown in Figure 2.

A 14-year-old male student was suspected to be infected with chickenpox on 16 Aug 2022 by his friend at another secondary school from a nearby district, where no previous outbreaks were reported. He subsequently introduced the virus to his two brothers (the 7- and 10-year-old cousins of the index case), who were residing in the same household.

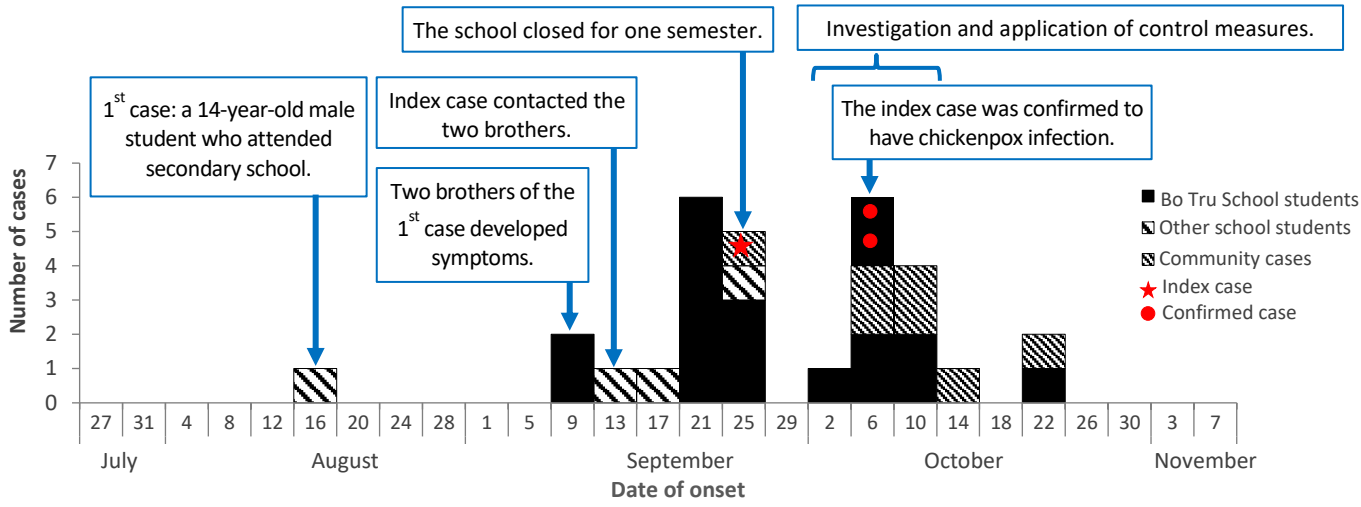

Figure 2. An Epidemic Curve of Chickenpox Cases in Bo Tru Subdistrict, Ranot District, Songkhla province during 1 Aug–24 October 2022 (n=30)

Characteristics of the Chickenpox Outbreak and Risk Factors

We identified 30 cases, including two adults aged over than 18 years, three teenagers and 25 children aged less than 13 years, giving an incidence rate of 4.0 per 1,000 population in Bo Tru Subdistrict. The male-to-female ratio was 1.5:1 and the median age was 11 years (IQR 7–38). The case fatality rate was 3.3% (1/30). Of the cases, 56.7% (17/30) were students from Bo Tru Elementary School and 43.3% (13/30) were other individuals living in the subdistrict. Two were smokers, and none reported consuming alcohol. None of the cases received the chickenpox vaccine nor had a history of prior chickenpox infection. Clinical symptoms were vesicles (100.0%), fever (83.3%) and papule (76.6%). Lesion sites occurred at legs (76.6%), trunk (70.0%) and arms (66.7%). The percentage of cases who visited local drug stores was 46.6% (14/30), and 23.3% (7/30) visited Ranot Hospital (outpatient clinic). There were no hospitalizations.

There were 16 infected households in Bo Tru Subdistrict, of which 14 contained a secondary case. We identified 75 contacts in 16 infected households, of which 41 reported to have a previous chickenpox infection and 34 had no history of chickenpox vaccination (Table 1). Therefore, the overall secondary attack rate among susceptible contacts was 41% (14/34). The number of household contacts of chickenpox cases and the percentage with chickenpox infection among household contacts, by age group, showed that the lowest proportion occurred among individuals under the age of 10 years (Table 1).

Table 1. Number of chickenpox household contacts in Bo Tru Subdistrict and percentage with a previous history of chickenpox infection among household contacts, by age groups, Bo Tru Subdistrict, Ranot District, Songkhla Province during 1 Aug 2022–24 Oct 2022

Age group (years)	Total cases (n=30) n (%)	Primary cases in households (n=16)	Secondary cases in households (n=14)	Number of household contacts (n=75)	Previous history of chickenpox infection among household contacts (n=41) (% (case/total))
≤5	8 (26.7)	4	4	8	12.5 (1/8)
6–9	13 (43.3)	7	6	10	10.0 (1/10)
10–14	7 (23.3)	4	3	9	23.8 (2/9)
15–25	0	0	0	12	50.0 (6/12)
26–40	0	0	0	14	78.6 (11/14)
>40	2 (6.7)	1	1	22	90.1 (20/22)

Laboratory results of a sample from the index case sent for RT-PCR testing for the Mpox virus was negative. A serum plasma sample sent for RT-PCR testing for varicella-zoster was positive. However, a serum sample tested negative for the herpes simplex I and II viruses. RT-PCR testing of samples taken from two suspected cases were positive for varicella-zoster.

From the walkthrough survey, the subdistrict was densely populated. There was a mosque and we observed adequate ventilation. Most individuals attending the mosque were wearing personal protective equipment. Many houses had double or single bedrooms that were shared by multiple individuals. Parents of the children infected by chickenpox were aware of their child's infection and stated that their children stayed at home. However, we noted that some cases were interacting and playing with other healthy children. During our investigation, Bo Tru Elementary School was closed due to the school break.

A total of 42 community households participated in the analytic study. On univariable analysis, being a close contact with a case (OR 6.50, 95% CI 1.46–28.8) and sharing personal utensils (OR 2.03, 95% CI 1.04–3.97), increased the risk of infection. However, on multivariable analysis, no statistically significant factors were associated with chickenpox infection (Table 2).

Table 2. Univariable and multivariable analysis in matched case-control by one year age in risk factors associated with chickenpox infection among residences, Bo Tru Subdistrict, Songkhla Province, during 1 Aug 2022–24 Oct 2022 (n=42, 21 pairs)

Exposure factors	Odds ratio (95% CI)	Adjusted odds ratio (95% CI)
Gender=male	3.02 (0.60–14.86)	-
Being students at Bo Tru Elementary School	3.50 (0.72–16.85)	-
Being closed contact with cases	6.50* (1.46–28.80)	3.19 (0.52–19.25)
Sharing personal utensils	2.03* (1.04–3.97)	1.52 (0.70–3.30)
Sharing room spaces	1.03 (0.71–1.49)	-
Attending religious activity	2.00 (0.36–10.91)	-

**P-value <0.1*

Action Taken

The joint investigation team worked collaboratively to strengthen the surveillance system for early case detection, notification, and proper management in the community. This involved cooperation with school teachers and local private clinics and drugstores in notifying chickenpox cases to local healthcare workers. Additionally, we provided risk communication and health education to the community, including distributing leaflets and conducting outreach activities at a community mosque. We also approached local religious leaders to request the temporary suspension of religious activities. Furthermore, we encouraged medical staff at Ranot Hospital to establish a service plan for high-risk groups and severe chickenpox cases. This included early detection and treatment of chickenpox cases and chickenpox vaccination for high-risk groups, and the establishment of an efficient referral system.

Discussion

The diagnosis of chickenpox in the deceased case and the outbreak was confirmed. Based on the clinical manifestation, the index case was initially suspected to have Mpox infection.[10] However, RT-PCR laboratory results confirmed the presence of the varicella virus. The diagnosis of this disease was primarily derived from the clinical presentations and further confirmed through laboratory testing, particularly RT-PCR, which is known for its high sensitivity.[11,12]

This index case of chickenpox infection is an active smoker, with no history of vaccination, suggests a possibility of increased risk of severe pneumonia and associated complications.[13] Complications in healthy adults tend to be more severe compared to children, with the risk being approximately 25 times higher.[14] Additionally, smoking can elevate the risk of respiratory complications in chickenpox-infected cases by up to 15-fold.[15,16] This increased risk is attributed to structural changes in the respiratory system and a decrease in immune response.[17] Therefore, it is important to provide risk communication to raise awareness of disease severity among high-risk groups, including adults who smoke, those who are not immunized, and among young children.

The recommended treatment for severe varicella pneumonia is intravenous acyclovir. However, the index case did not receive this treatment during his life-threatening period due to the late detection and unavailability. Intravenous acyclovir has been proven to be a highly successful treatment for chickenpox cases with severe pneumonia and the fatality rate is higher in chickenpox-infected adults who do not receive this treatment.[14,18,19] Therefore, introducing

clinical practice guidelines for management of chickenpox in complicated cases at district hospitals should be considered. This would involve early detection and treatment as well as the establishment of an efficient referral system.

The Centers for Disease Control and Prevention recommends varicella vaccination for outbreak prevention and control to provide protection to people not yet exposed and to shorten the duration of possible outbreaks.[20] Offering the vaccine within 3–5 days of exposure to a varicella rash is important to provide the greatest protection.[21] However, none of the cases in this outbreak had ever received the chickenpox vaccination (the vaccine is not included in Thailand's Expanded Program on Immunization), probably because most (68%) of the Thai population already has varicella antibodies.[22] Moreover, in Thailand, the cost of the vaccine is high ($US 80–100/dose).[23] However, in future outbreaks, vaccination should be taken into consideration and offered to high-risk groups or those without chickenpox immunity.

Risk factors found in this study, being a close contact with a case and sharing personal utensils, were similar to the results of two previous studies.[5,9] Therefore, if chickenpox cases are detected in a household or school, they should be isolated from susceptible persons such as adults with no immunization, and personal utensils should not be shared.[24,25]

In this study, delays in outbreak detection and subsequent actions were identified. The outbreak began in July 2022 and lasted until the beginning of October 2022, roughly spanning around two generations. It was detected among family members in the community. The well-established disease surveillance system within the community and prompt application of control measures for cases until their recovery were crucial in controlling this outbreak.[26,27]

Limitations

Only three cases in this investigation were laboratory confirmed. Our results from the descriptive study and risk factors from the analytic study may therefore be inaccurate. However, as chickenpox symptoms are recognizable, we mainly used history of illness in selecting cases and controls. Moreover, there was information bias of past exposures among varicella cases that were more likely to remember their risk factors compared to the controls, resulting in differential misclassification. This may have resulted in an overestimate of the risk. However, we triangulated our results by having the study subjects ask their family members when they were uncertain.

Recommendations

For effectiveness of the outbreak control, risk communication in the community was crucial. We recommended that chickenpox cases detected in a household be isolated and separate personal utensils used by household members. Introduction of chickenpox clinical practice guidelines in complicated cases at district hospitals was recommended, focusing on early detection and treatment in high-risk and susceptible group, such as adults over the age of 12, pregnant women, and active smokers. The chickenpox vaccination in the future outbreak should be offered after exposure. There should be surveillance system strengthening in specific areas such as elementary schools or households containing high-risk groups. This can be achieved by involving community participation such as private clinics and drug stores to aid early detection and response.

Conclusion

An outbreak of chickenpox occurred in a community resulting in one death from severe pneumonia. The dead case was an active smoker. None of the cases received chickenpox vaccination or had a history of chickenpox infection. The secondary attack rate of the close community contacts was 41%. Potential risk factors associated with this outbreak were being a close contact with a case and sharing personal utensils. We strengthened the surveillance system to facilitate early detection and community risk communication. Coordinating standard treatment guidelines for complicated cases was essential.

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Conflicts of Interest

The authors declared no conflict of interest.

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